US005848884A

United States Patent [19]

Haustein et al.

[11] **Patent Number: 5,848,884**

[45] **Date of Patent: Dec. 15, 1998**

[54] **FLARE VENT IGNITION ASSEMBLY**

[75] Inventors: **Kevin Haustein**; **Tom O'Shea**, both of Stettler, Canada

[73] Assignee: **Judy O'Shea**, Stettler, Canada

[21] Appl. No.: **713,218**

[22] Filed: **Sep. 12, 1996**

[51] **Int. Cl.**[6] **F23D 00/00**

[52] **U.S. Cl.** **431/202**; 431/258; 431/264

[58] **Field of Search** 431/202, 80, 154, 431/155, 279, 258, 263, 264; 361/253, 247

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,013,395	3/1977	Wormser	431/9
4,711,629	12/1987	Macdonald	431/264
4,854,855	8/1989	Rajewski	431/202
5,291,367	3/1994	Rajewski	361/253

FOREIGN PATENT DOCUMENTS

763761	7/1967	Canada	158/90
781249	3/1968	Canada	158/82
929847	7/1973	Canada	158/15
1054508	5/1979	Canada	158/8
1089662	11/1980	Canada	158/8
1288965	9/1991	Canada	67/37
2054810	11/1991	Canada .	
2125634	6/1994	Canada .	
2448692	10/1980	France	431/202

OTHER PUBLICATIONS

Mactronic Solar Charged Flare Ignition Systems for Remote Offschore Service (2 page brochure.

Tornado Pilot Monitoring and Relite System Model:TP-MR–A (110V DTT–23) (5page brochure).

Tornado Retractable Arch Light Models:TEIS–CS12,C24, C110, e/w CDS–9324/lgs Control Card (5 page brochure).

Tornado Flare Ignitor (Propane) Model: TSI #3 (7 page brochure).

Operating and Maintenance Manual for the Tornado Flare Stack Ignitor Model TSI#6 (5 pages).

Tornado Burner Tube Pilot Model TBTP #6 (Fuel Gas) C/W Peizo Push Button Ignition General Arrangement (3 page brochure).

Tornado Flare Systems: Arch Light Electronic Ignitors (6 page brochure).

Tornado Flare Systems Flare Tips (1 page).

The Tornado Flame Torpedo (1 page).

Tornado Flare Systems Freezing and Plugging Prevention (1 page).

Tornado Flare Systems Ceramic Pilot Nozzle (1 page).

Tornado Flare Systems Smokeless Flare Tips (1 page).

Tornado Flare Systems Enhanced Burn Unit (1 page).

Tornado Flare Systems Stays Lit Ceramic Burner Tube Pilots and Ignition Options (1 page).

TornadoFlare Systems Burner Assembly (1 page).

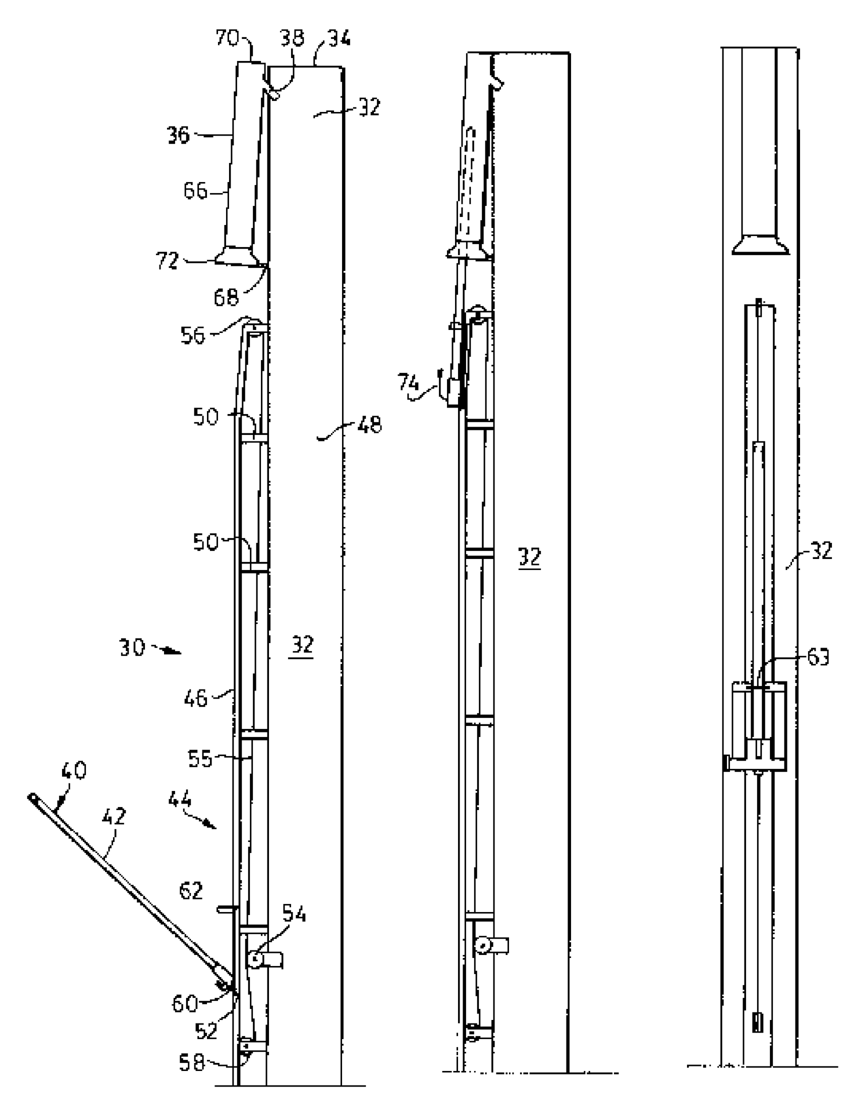
Company Capabilities, Products and Services (Tornado Flare Systems) (4 page brochure).

Primary Examiner—James C. Yeung
Attorney, Agent, or Firm—Thomas E. Malyszko

[57] **ABSTRACT**

In an ignition assembly for a flare vent having an open terminal end for venting waste gases, a hollow tubular stripper is located adjacent a generally upright exterior wall of the flare vent and has a lower opening and an upper opening proximate to the terminal end of the flare vent. A conduit for diverting some of the waste gases from the flare vent to the stripper is located below both the upper opening of the stripper and the terminal end of the flare vent. A pilot has an ignition end to ignite the diverted waste gases in the stripper to produce an ignition flame at the upper opening of the stripper, which in turn ignites the waste gases exiting the terminal end of the flare vent. The pilot is housed in a sleeve having an open first end for receiving the pilot and an open second end for exposing the ignition end of the pilot to the waste gases in the stripper. The sleeve is insertable into the stripper and, when inserted, allows air flow through the stripper to produce the ignition flame and to cool the sleeve. A track is attached to the exterior wall of the flare vent for moving the sleeve and pilot between an inoperative position near the base of the flare vent and an operative position near the terminal end of the flare vent. In the operative position the second end of the sleeve and the pilot are located within the stripper below the stream of waste gas entering the stripper through the conduit.

31 Claims, 9 Drawing Sheets



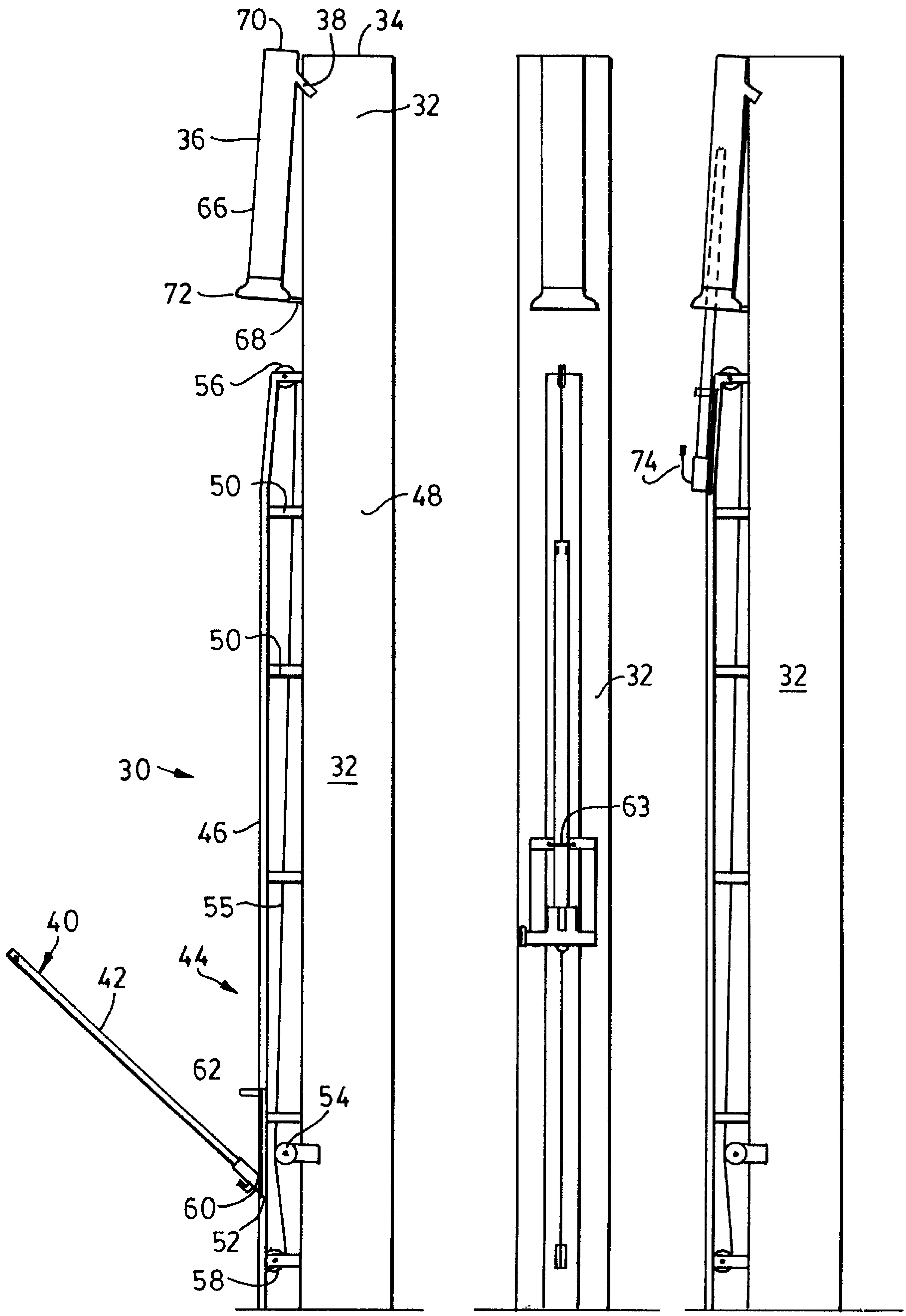


FIG. 1 FIG. 3 FIG. 2

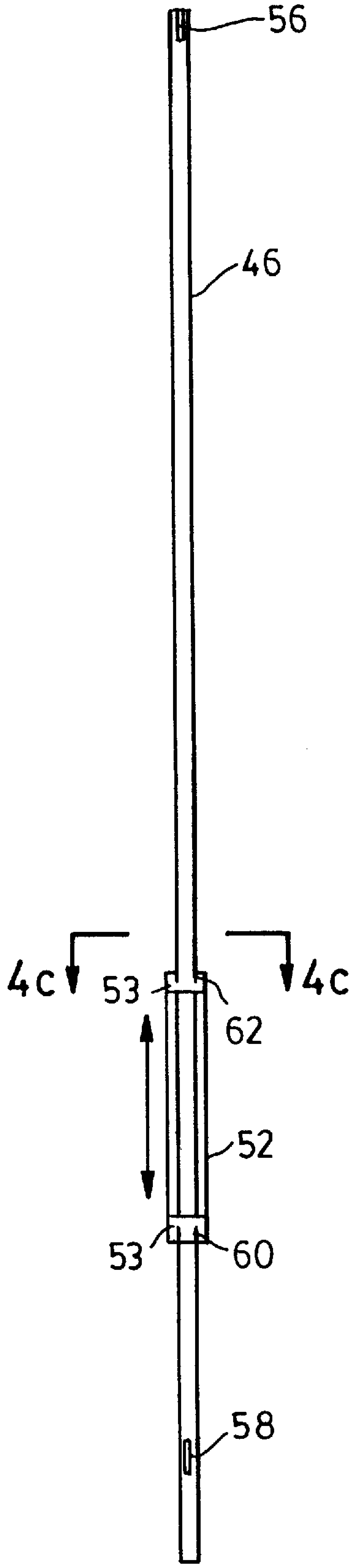


FIG. 4a

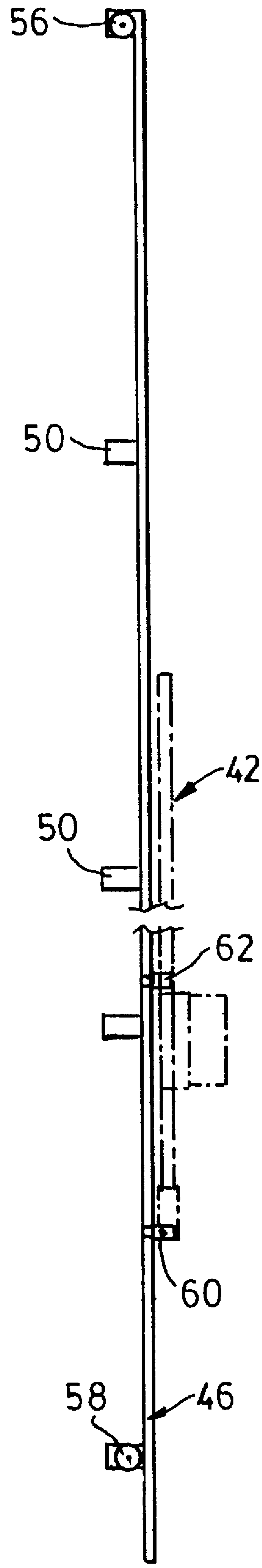


FIG. 4b

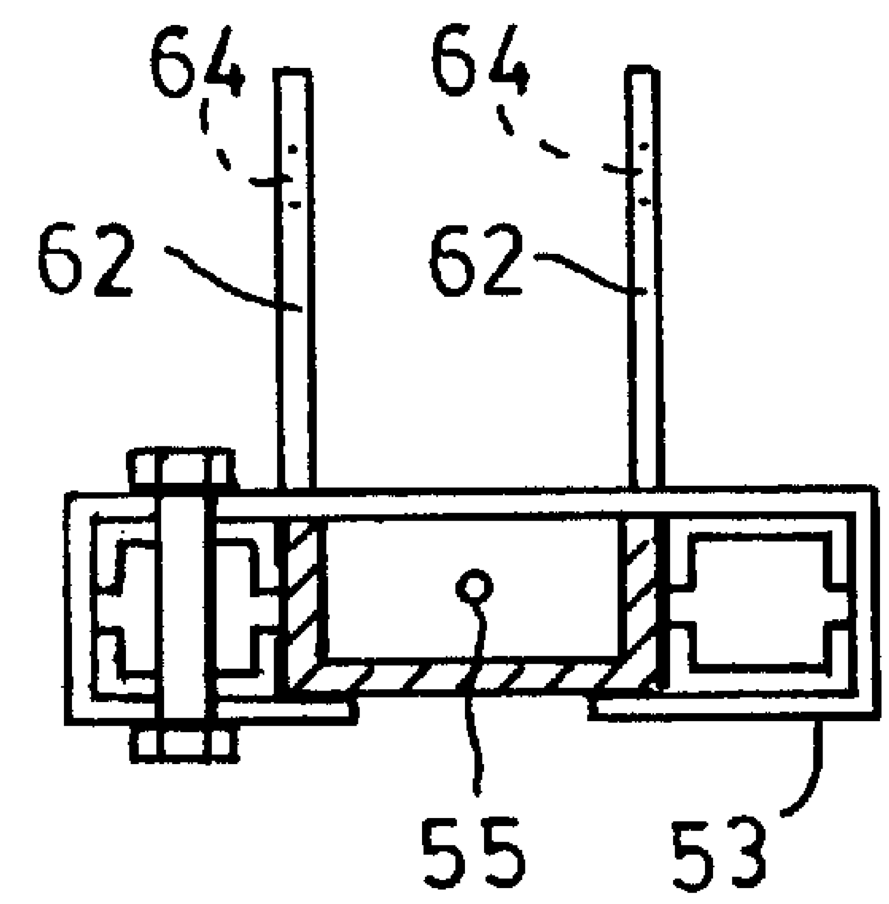


FIG. 4c

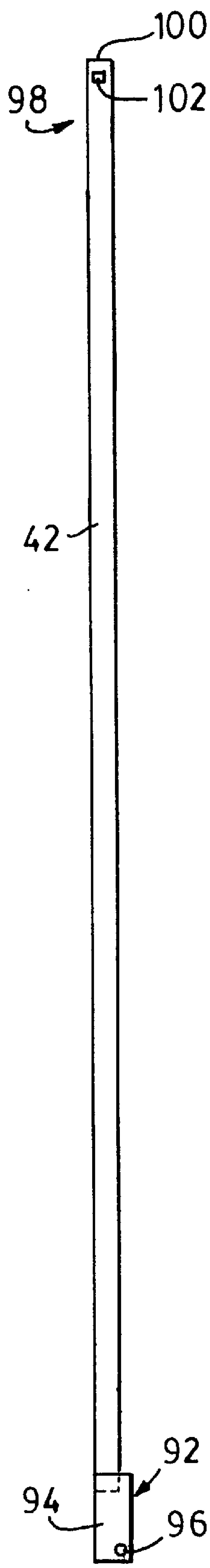


FIG. 5

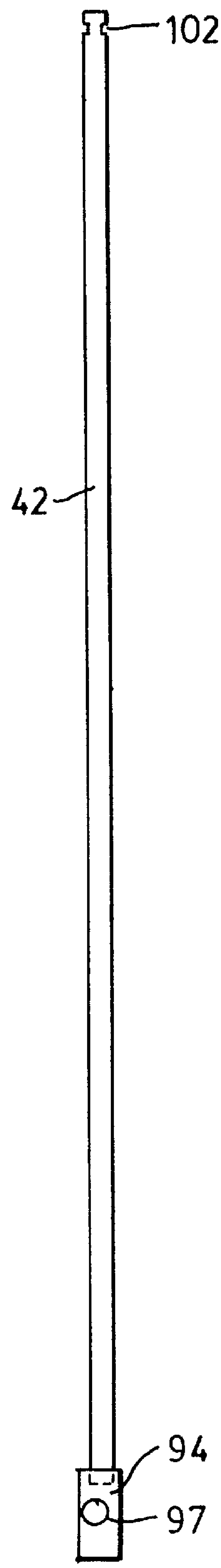


FIG. 6

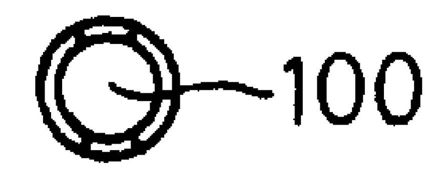


FIG. 7a

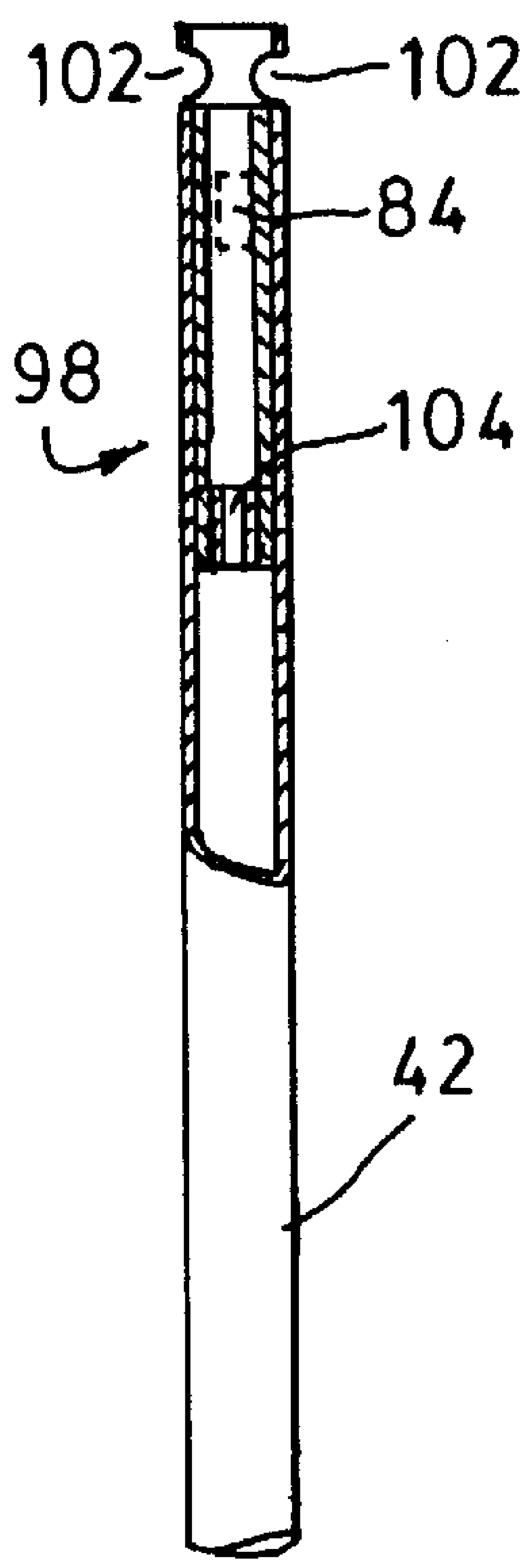


FIG. 7

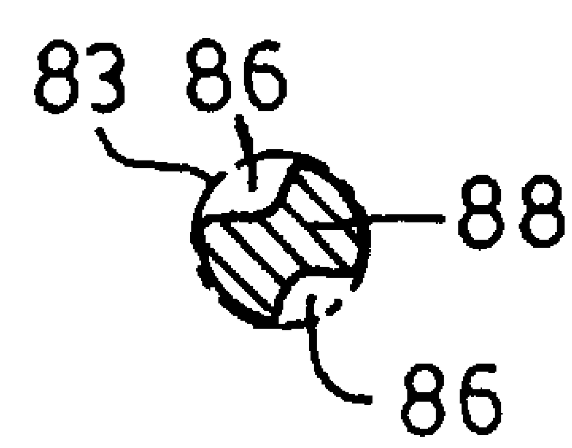


FIG. 10

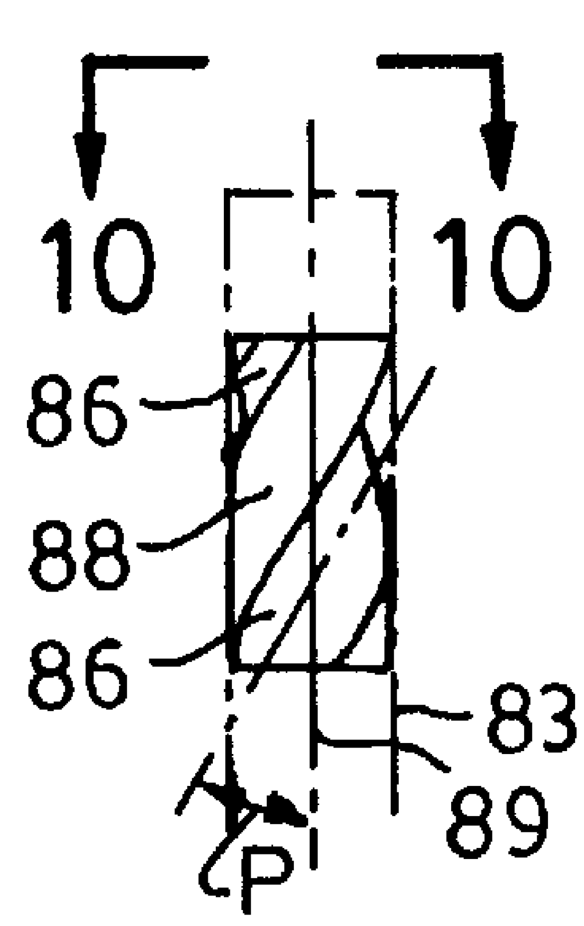


FIG. 9

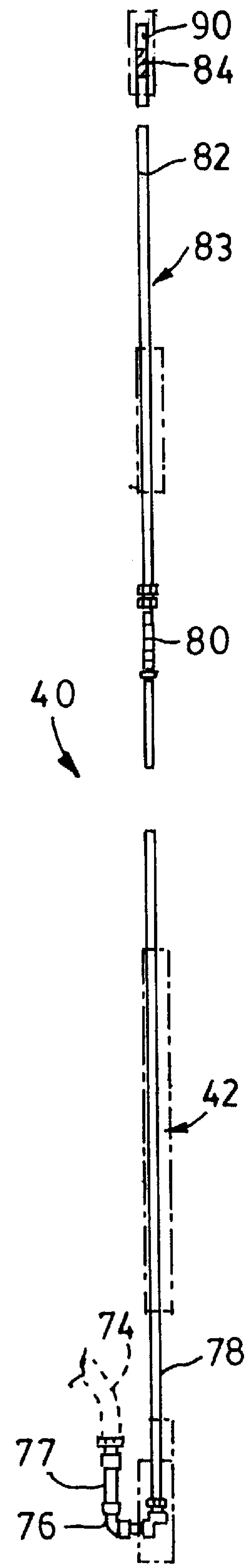


FIG. 8

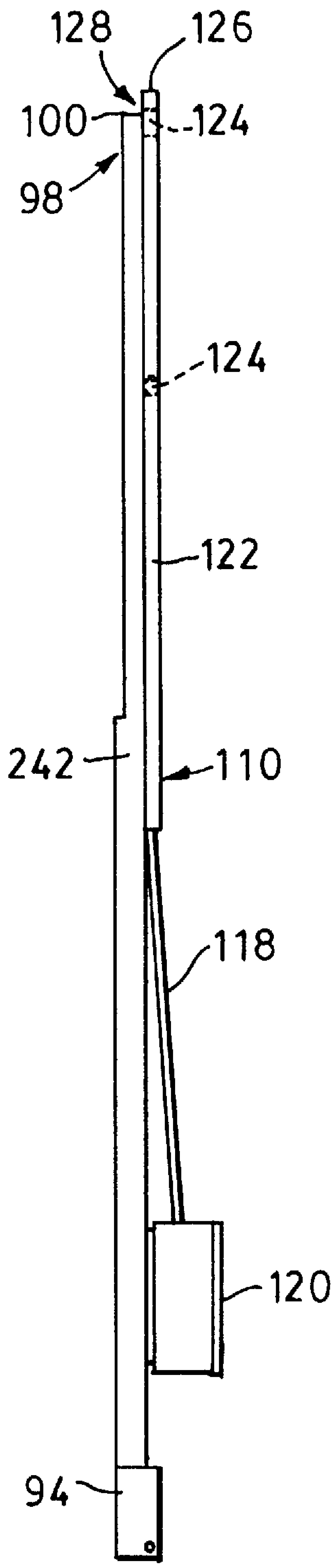


FIG. 11

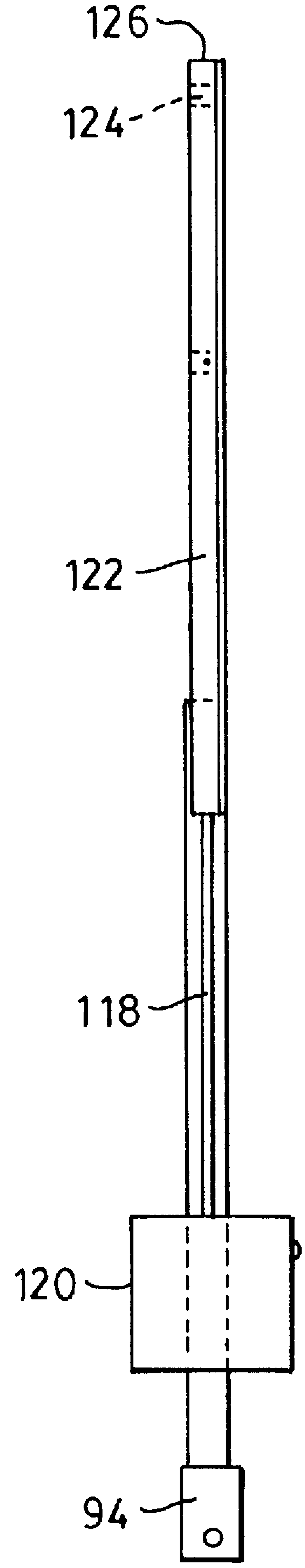


FIG. 12

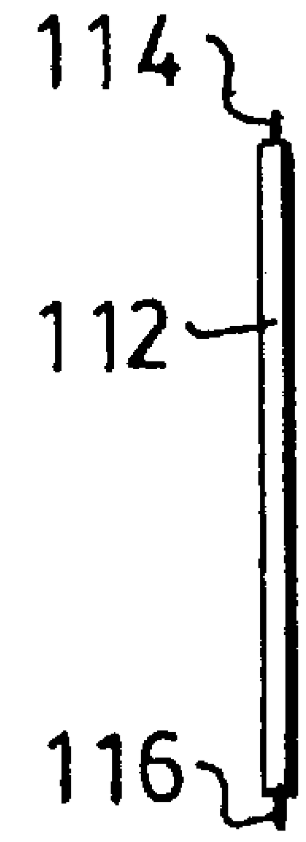


FIG. 14

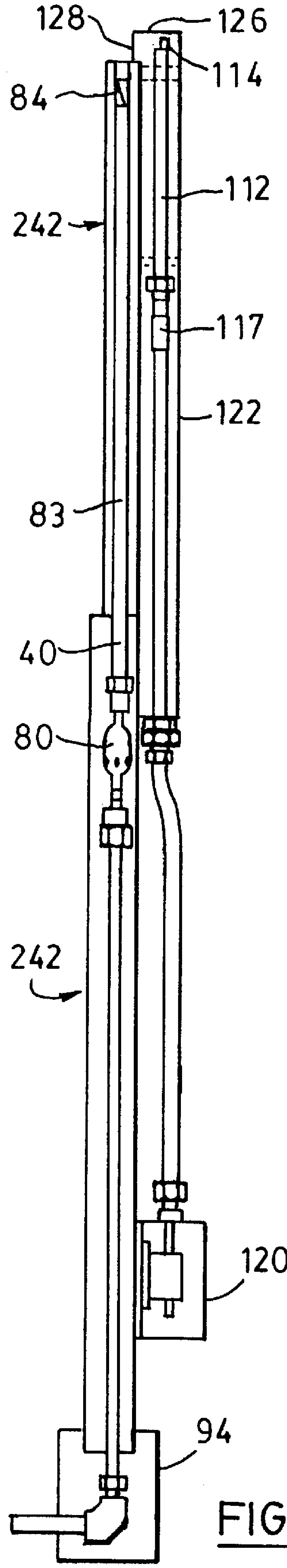


FIG. 13

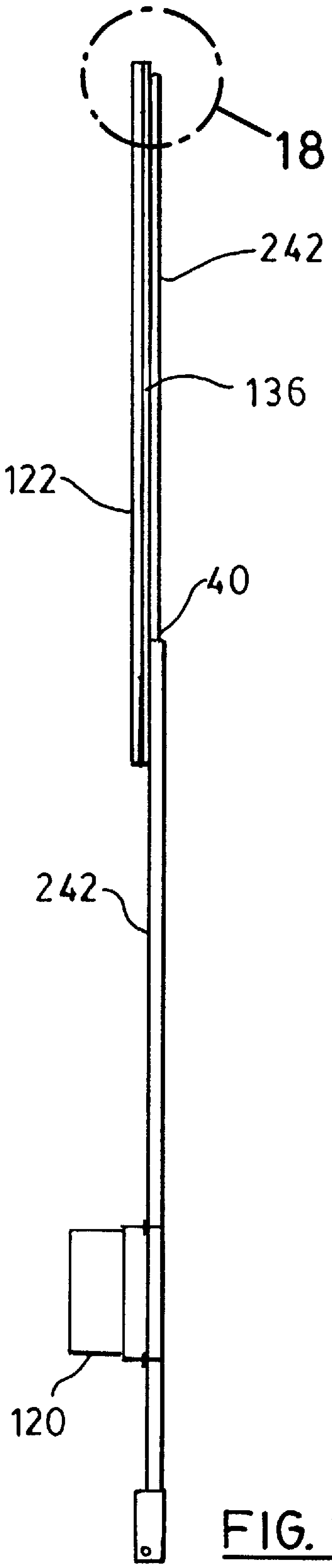


FIG. 15

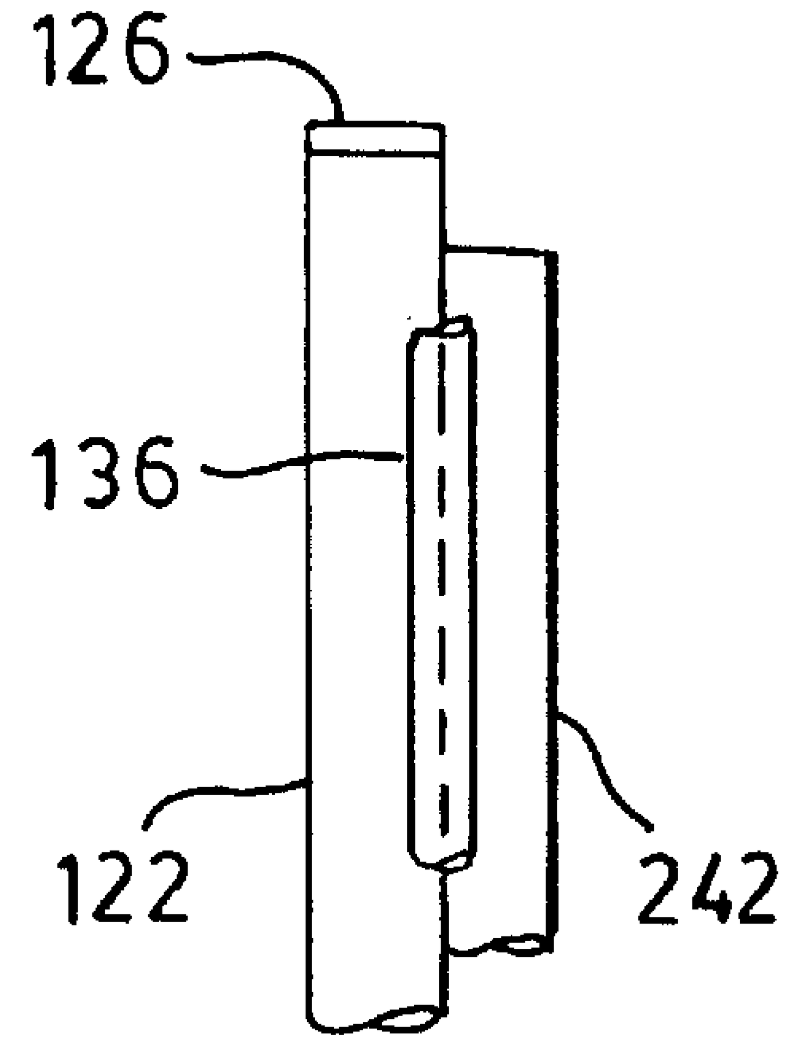


FIG. 18

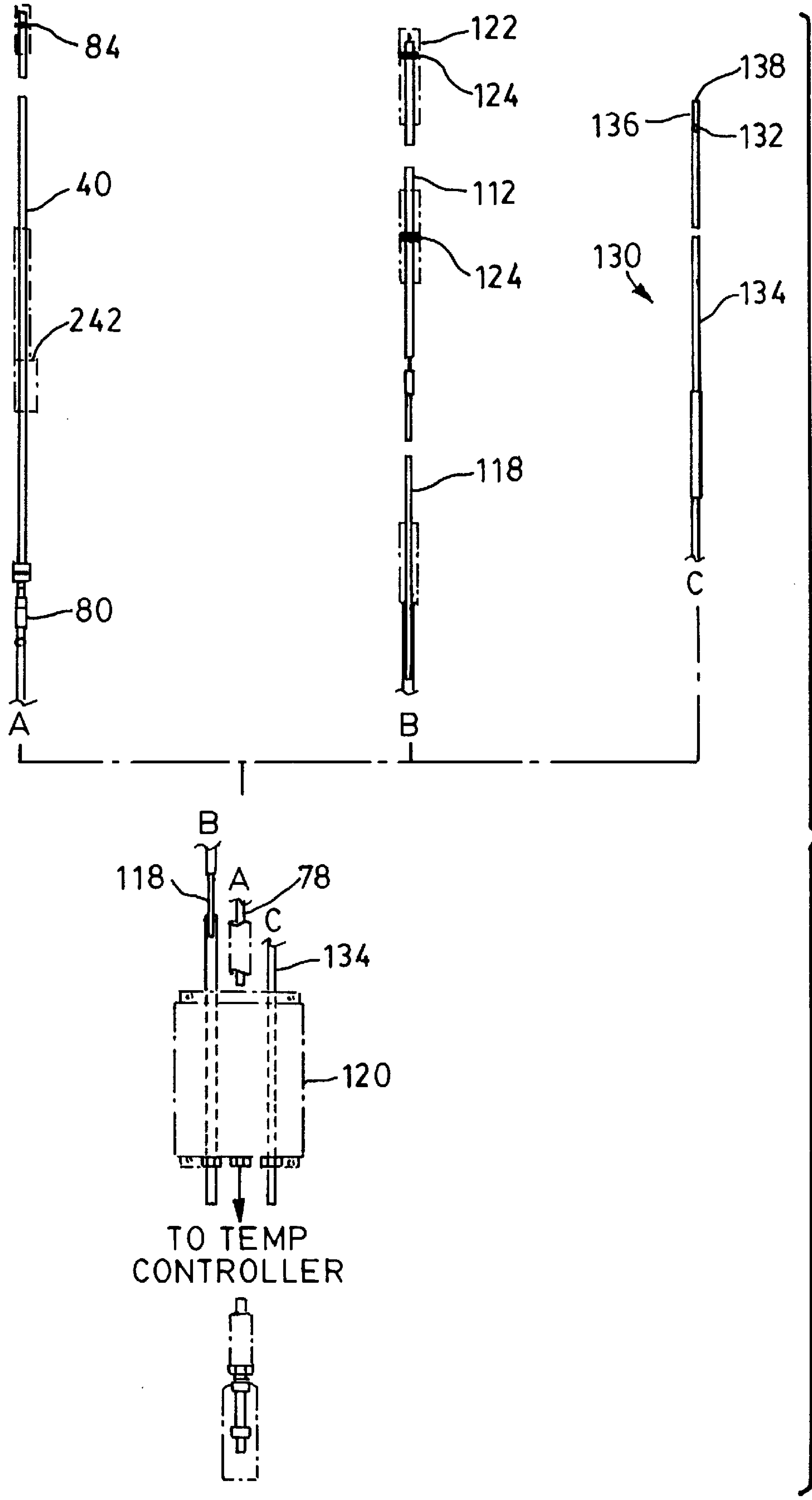

84
40
242
80
A
122
124
112
124
118
B
138
136
132
130
134
C
B
118
A
78
C
134
120
TO TEMP
CONTROLLER

FIG.16

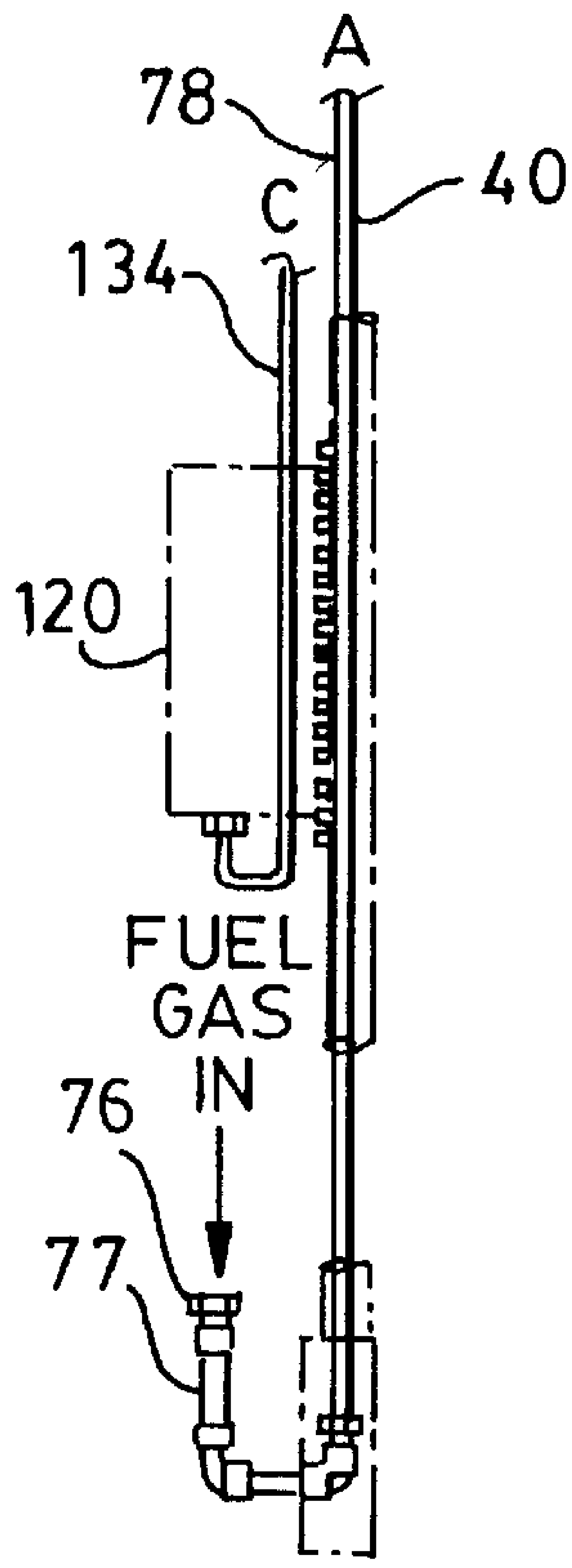


FIG. 17

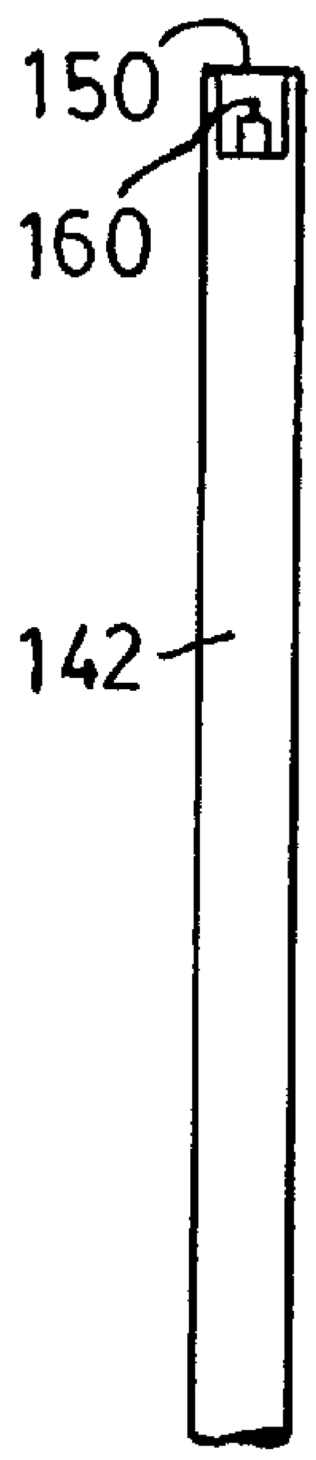


FIG. 23

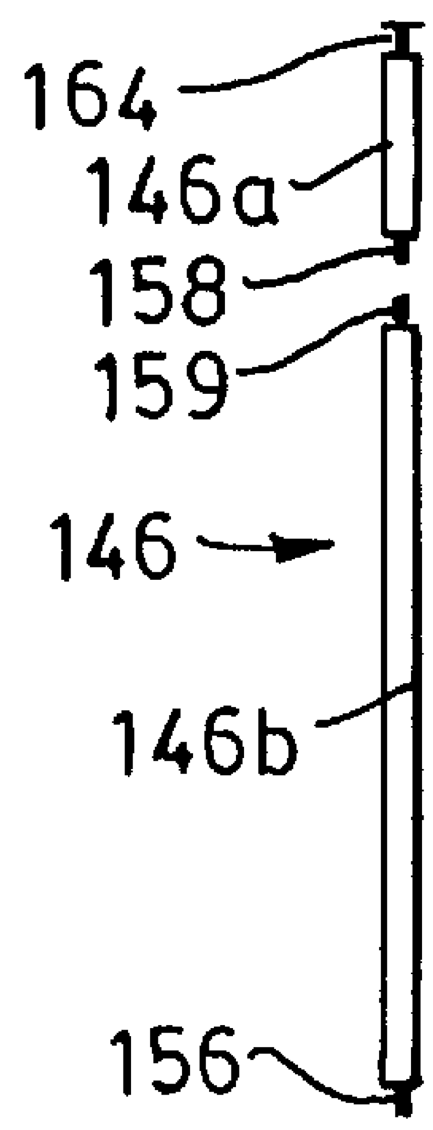


FIG. 22

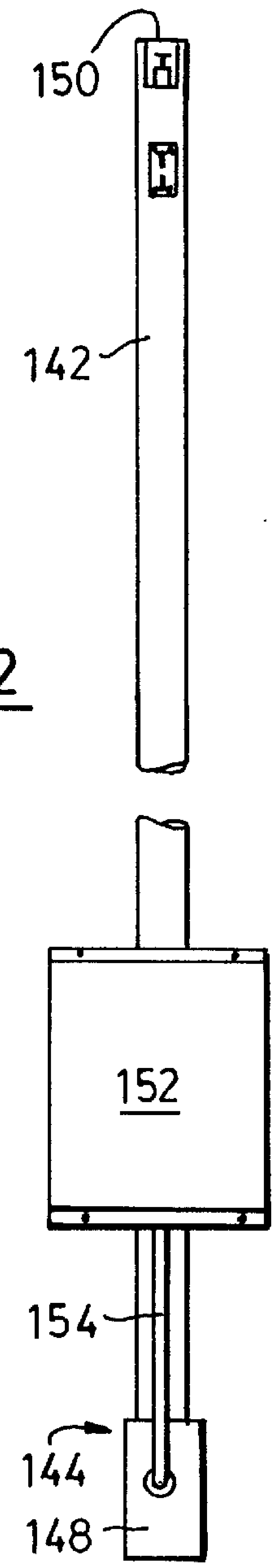


FIG. 19

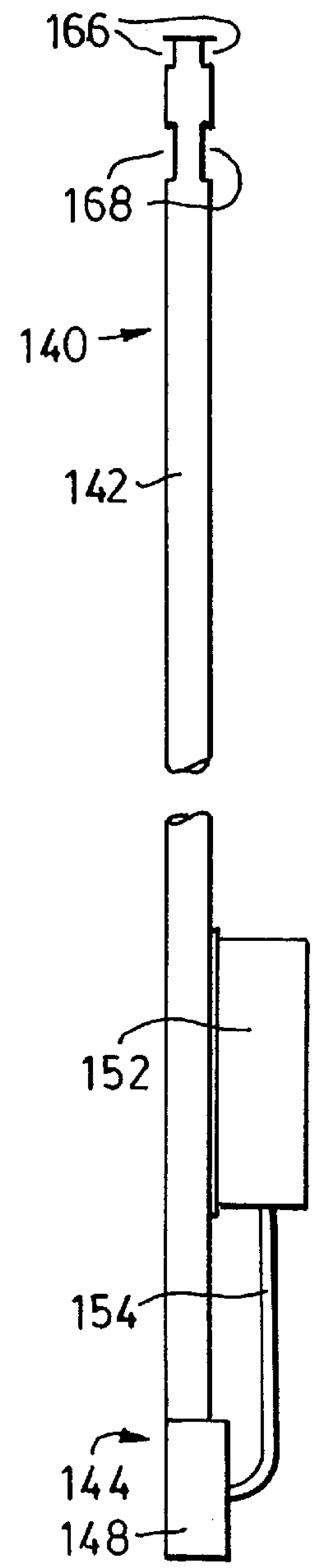


FIG. 20

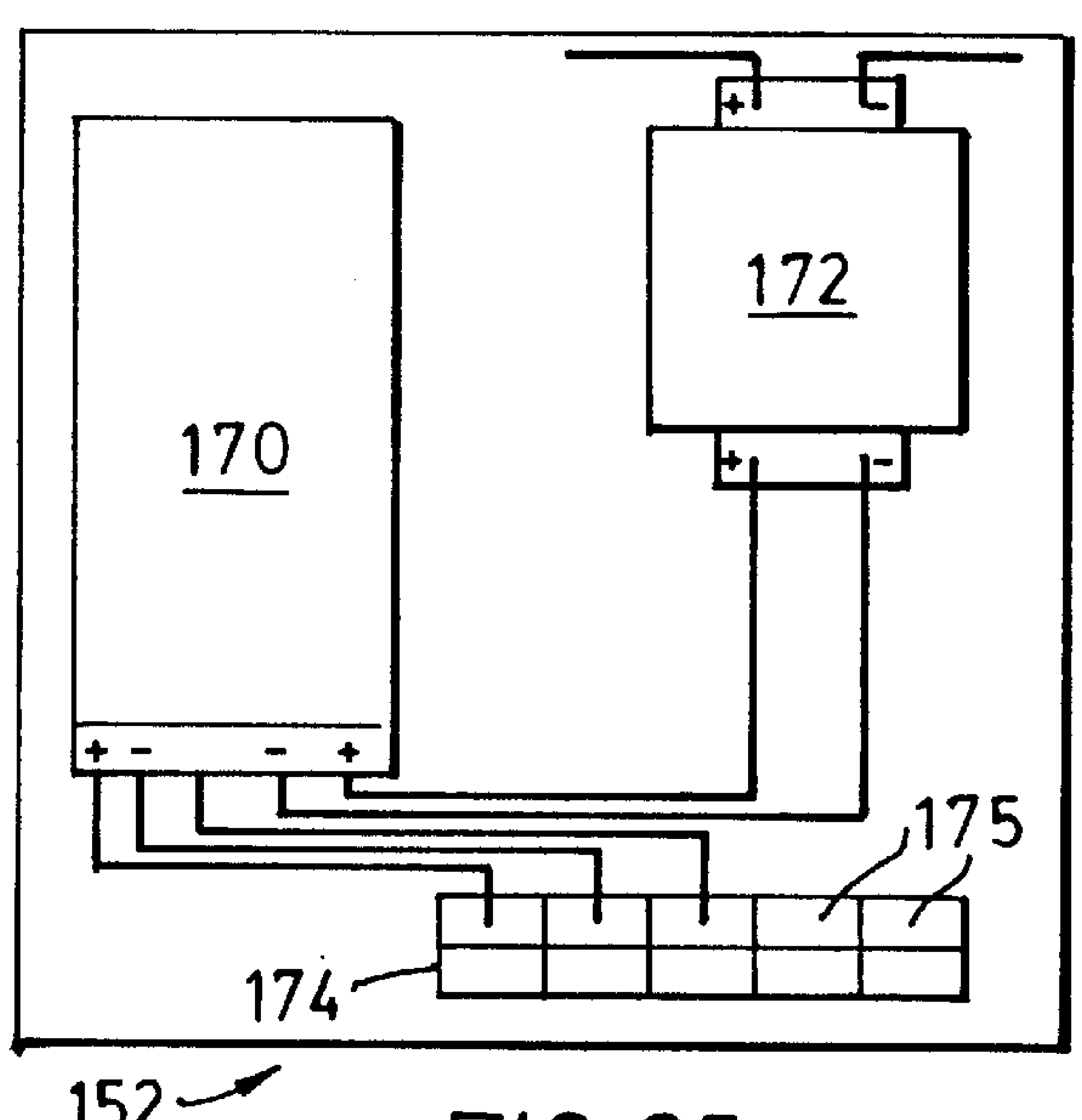


FIG. 25

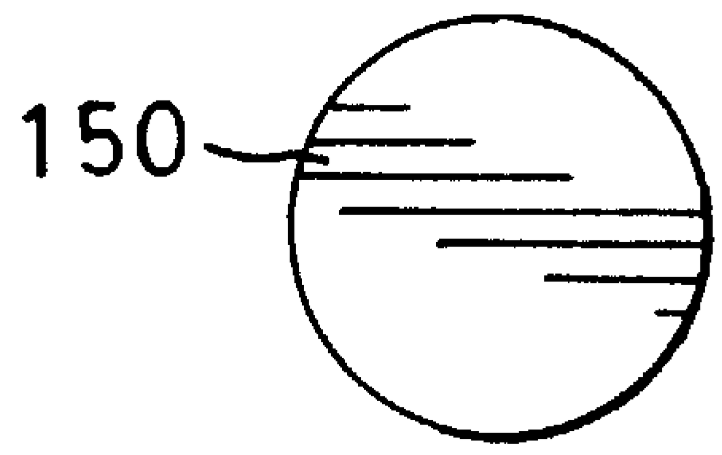


FIG. 24b

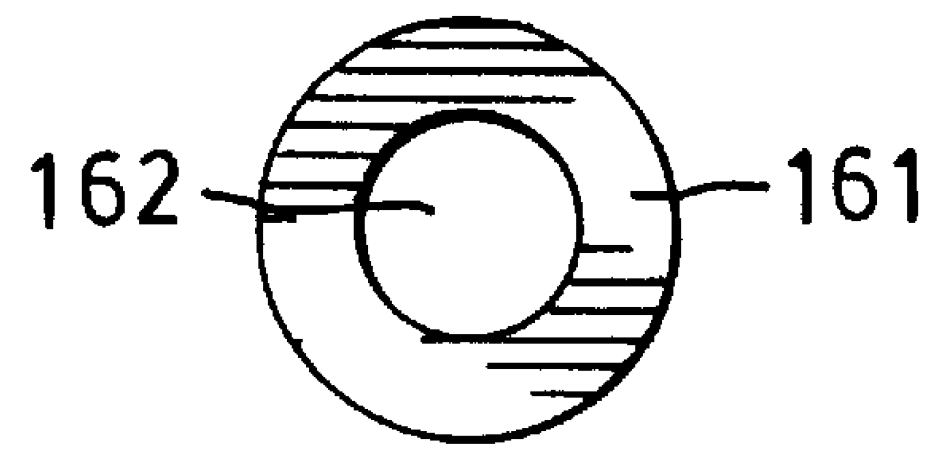


FIG. 21b

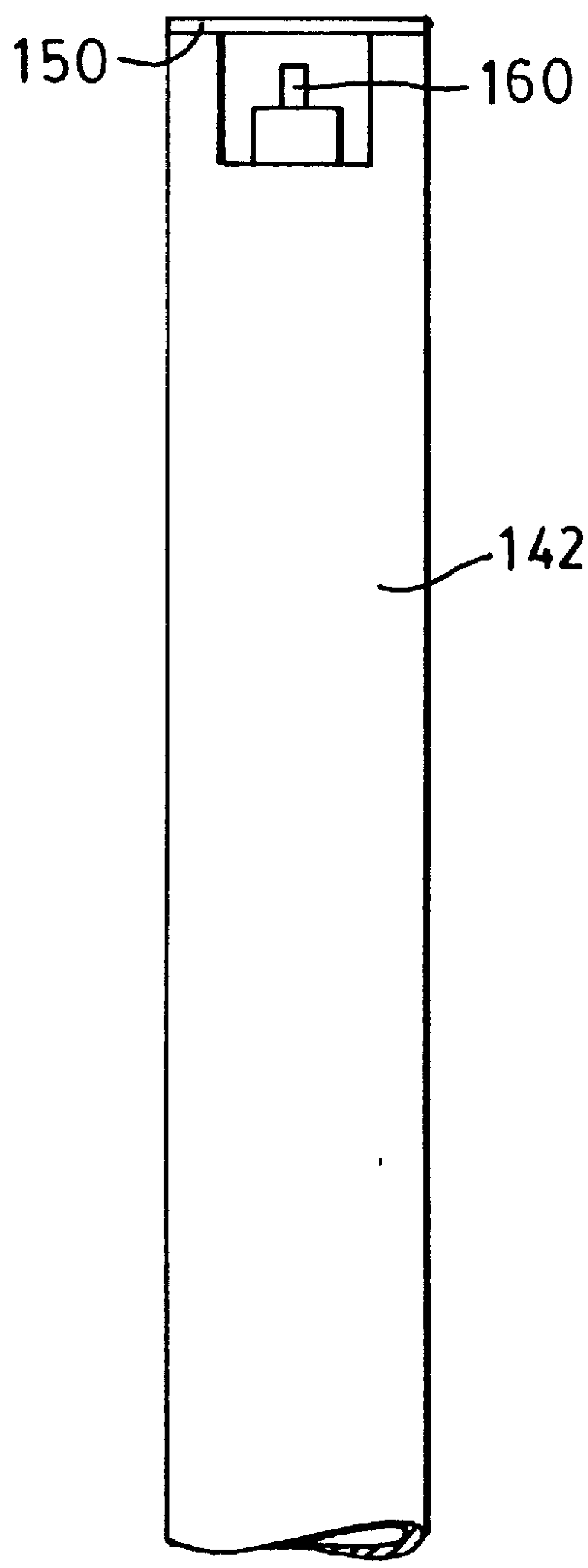


FIG. 24a

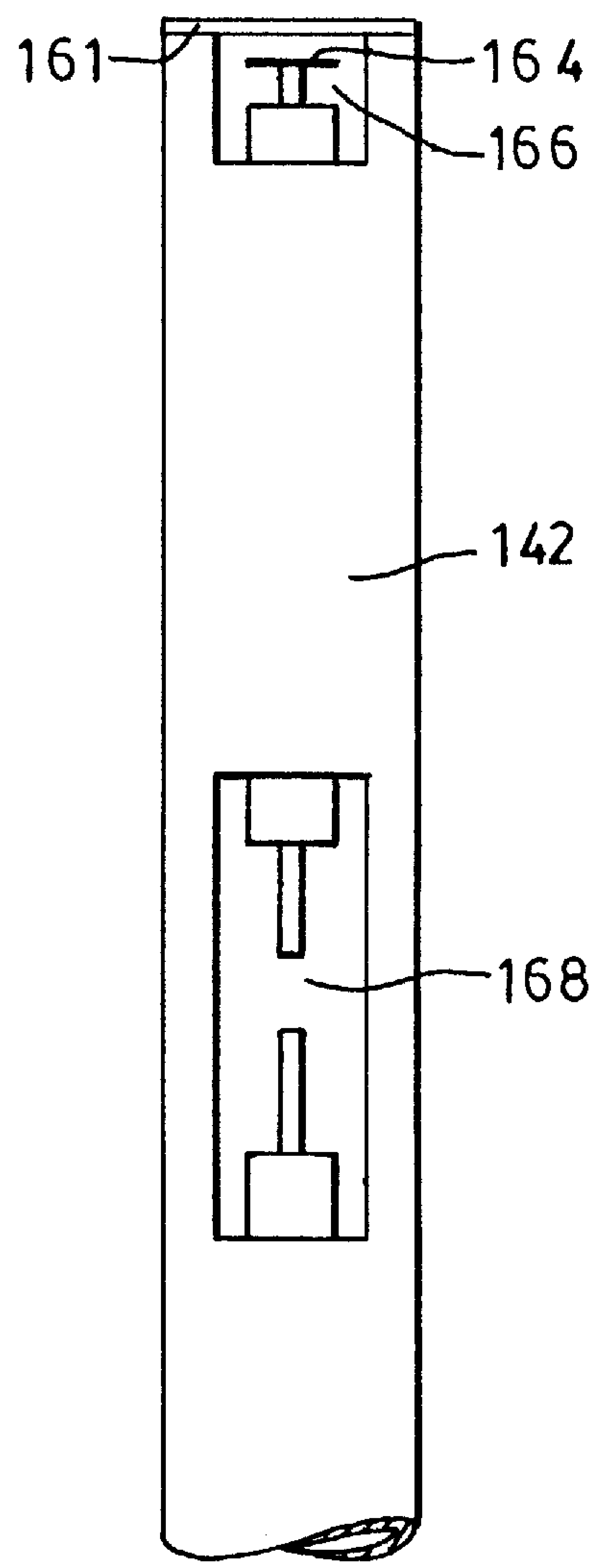


FIG. 21a

FLARE VENT IGNITION ASSEMBLY

FIELD OF THE INVENTION

The present invention relates to an ignition assembly for flare vents used in the oil and gas producing industry, in particular for flare stacks, flare pits and burner tubes.

BACKGROUND OF THE INVENTION

Oil pumped to the earth's surface at oil wells gives off associated or waste gases (such as sour gas) which must be burned off for environmental purposes. Typically these waste gases are sent up a tall flare vent (eg. a flare stack) which can reach heights of 300 feet (about 90 meters) or more to keep the large flare or flame atop the stack a safe distance above ground level. The flare must be kept burning to avoid the release of the raw waste gases into the atmosphere. It is not uncommon for the flare to be extinguished due to wind conditions and interruptions of waste gas flow up the stack. Hence, an ignition assembly is normally provided to re-ignite the flare.

Ignition assemblies generally utilize one of two types of pilots to reignite a flare, namely a flame-type pilot which produces a fuel-fed flame (referred herein as a "pilot flame"), and an electrode-type pilot which produces electrical arcs or "sparking". Such prior art pilots are typically located at the open terminal end of the flare stack right in or beside the stream of waste gases traveling up the stack. Although such arrangements ensure that the pilot is exposed to the waste gas stream for ignition purposes, there are several resultant drawbacks.

One disadvantage of these prior pilots is that such direct and continuous exposure to the corrosive elements in the waste gases causes relatively rapid or premature corrosion of the pilot, even though it may be constructed of corrosion resistant materials such as stainless steel. Another disadvantage is the pilot's close proximity and resultant exposure to the intense heat of the flare atop the stack, which can reach temperatures in excess of 1800 degrees F. (about 1000 degrees C.). Such elevated temperatures accelerate degradation of the pilot. As a result, prior art pilots require frequent maintenance, repair and replacement, which adds significantly to the operating costs of a flare stack.

Prior art flame-type pilots suffer from other drawbacks or inefficiencies as well. They tend to consume relatively large amounts of fuel (such as propane) and require high fuel pressures to produce and maintain the pilot flame. These pilots typically consume 3 to 6 liters or more of fuel per day and run on 12 to 18 psi pressure, depending on particular circumstances. Hence, operating costs (apart from maintenance) can be expensive as well.

What is desired therefore is an ignition assembly which overcomes the limitations and disadvantages of these other prior art devices. Preferably the assembly should be located away from the open top of the flare stack to avoid exposing the pilot to the elevated temperatures of the flare atop the flare vent, and in addition should have a means to help cool the pilot. Further, the pilot should not be directly exposed to the flow of the corrosive waste gases in the stack. The ignition assembly should also be relatively fuel efficient and function on relatively low fuel pressures to further reduce operating costs.

SUMMARY OF THE INVENTION

In one aspect the present invention provides an ignition assembly for a flare vent having an open terminal end for venting waste gases comprising:

a stripper comprising a generally hollow tubular member located adjacent a generally upright exterior wall of said flare vent, said tubular member having a lower opening and an upper opening proximate to said terminal end of the flare vent;

a conduit for waste gas communication from said flare vent to said stripper, said conduit being located below both said upper opening of the stripper and said terminal end of the flare vent;

a pilot having an igniting end for igniting waste gases entering said stripper through said conduit to produce an ignition flame at said upper opening of the stripper, said ignition flame igniting waste gases exiting said terminal end of the flare vent;

an elongate tubular housing for said pilot having an open first end for exposing said pilot igniting end to waste gases in the stripper, wherein said housing is insertable into said stripper and when inserted allows air flow through said stripper for producing said ignition flame and for cooling said first end of the housing; and

a track attached to said exterior wall of the flare vent for moving said housing and pilot between an inoperative position near the base of said flare vent and an operative position near said terminal end of the flare vent, wherein in said operative position said first end of the housing and said pilot are located within said stripper below said conduit.

In another aspect the invention provides an ignition assembly for an upright flare vent having an open terminal end for venting waste gases comprising:

a generally elongate pilot having an igniting end;

a generally elongate sleeve housing said pilot, said sleeve having an open first end for exposing said igniting end to the ambient;

a hollow stripper mounted adjacent an exterior wall of said flare vent, said stripper having opposed upper and lower openings, said upper opening being located adjacent said terminal end of the flare vent;

a conduit located below both said upper opening of the stripper and said terminal end of the flare vent for diverting a portion of said waste gases from said flare vent into said stripper, said diverted gases forming a stream upon exiting said conduit in said stripper;

a track attached to said exterior wall of the flare vent for locating said igniting end of the pilot and said first end of the sleeve in said stripper in close proximity to said stream of waste gases from the conduit.

DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. **1** is an elevated side view of an upright flare stack carrying an ignition assembly in an inoperative position according to a first, preferred embodiment of the present invention;

FIG. **2** shows the ignition assembly of FIG. **1** in an operative position;

FIG. **3** is an elevated front view of the ignition assembly of FIG. **1** between the operative and inoperative positions;

FIG. **4***a* is an enlarged front view of a track of FIG. **1**;

FIG. **4***b* is a side view of the track of FIG. **4***a;*

FIG. **4***c* is a sectional view taken on line **4***c*—**4***c* of FIG. **4***a;*

FIG. **5** is an elevated side view of a pilot housing of the ignition assembly of FIG. **1**;

FIG. **6** shows the pilot housing of FIG. **5** rotated 90 degrees counterclockwise;

FIG. **7** is a close-up view, partially broken away, of a top potion of the pilot housing of FIG. **6**;

FIG. **8** is a side view of a pilot of the ignition assembly of FIG. **1** with portions of the pilot housing shown in ghost outline;

FIG. **9** is a close-up sectional view of a top portion of the pilot of FIG. **8** showing a flame spreader embedded therein;

FIG. **10** is a plan view taken along the line **10—10** of FIG. **9** of the flame spreader;

FIG. **11** is an elevated side view of a second embodiment of the ignition assembly showing an electrode assembly attached to the pilot housing;

FIG. **12** shows the electrode assembly and pilot housing of FIG. **11** rotated 90 degrees clockwise;

FIG. **13** is a transparent view of the pilot housing and electrode assembly of FIG. **11**;

FIG. **14** is an isolated view of an electrode of the electrode assembly of FIG. **13**;

FIG. **15** is an elevated side view of a third embodiment of the ignition assembly showing portions of an electrode assembly and a thermocouple assembly attached to a pilot housing;

FIG. **16** is a schematic broken apart view of the ignition assembly of FIG. **15**;

FIG. **17** is a close-up side view of a lower portion of the pilot and thermocouple assembly of FIG. **16**;

FIG. **18** is a close-up view of the circled area in FIG. **15**, partly broken away;

FIG. **19** is an elevated front view of a fourth embodiment of an ignition assembly according to the present invention;

FIG. **20** shows the ignition assembly of FIG. **19** rotated 90 degrees clockwise;

FIG. **21***a* is a close-up view of a top portion of the ignition assembly of FIG. **19**;

FIG. **21***b* is a plan view of FIG. **21***a;*

FIG. **22** is an isolated view of an electrode of the ignition assembly of FIG. **19**;

FIG. **23** is an alternate embodiment of the top portion of the ignition assembly of FIG. **19**;

FIG. **24***a* is a close-up view of FIG. **23**;

FIG. **24***b* is a plan view of FIG. **24***a;* and

FIG. **25** is a schematic view of a control assembly for the ignition assemblies of FIGS. **19** and **23**.

DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is first made to FIGS. **1** to **3** which show an ignition assembly according to a first embodiment of the invention (generally indicated by reference numeral **30**) mounted to a generally vertical or upright flare stack **32** commonly used in the oil and gas industry to vent and burn off unwanted gaseous by-products, also known as associated gases or waste gases, such as sour gas, through an open terminal end **34**. Although the invention may be used with other types of flare vents such as flare pits and burner tubes, a flare stack is used for illustrative purposes.

The ignition assembly **30** has several elements, including a stripper **36** with a conduit **38**, and a pilot **40** located in a sleeve or housing **42** which travels on a track system **44** operated by a technician or other user. There are two alternate types of pilot in the present invention. A first pilot

type (FIGS. **1–18**), referred to as a "flame pilot", operates on a fuel, like propane or natural gas, to produce a flame (referred to later as a "primary flame" or a "pilot flame") for igniting gases entering the stripper **36** through conduit **38**. A second pilot type (FIGS. **19–25**) uses an electrode to produce sparks for igniting those same gases in the stripper **36**, and will be referred to as a "sparking pilot". The ignition assembly **30** having the flame pilot comes in three versions. A first version (FIGS. **1–10**) is called a "manual light" because the pilot flame must be lit manually by a technician upon being extinguished. A second version (FIGS. **11–14**), called an "auto-light", incorporates an electrode assembly to determine when ignition current or sparks at a preset voltage, duration and time interval (for example, one second of sparking at 20,000 V every other second) are needed to re-light the pilot flame automatically should it be extinguished. Lastly, a third version of the flame pilot (FIGS. **15–18**), called a "sensored auto-light", is similar to the auto-light version except that a temperature sensitive thermocouple assembly is employed to turn the electrode assembly on and off when the pilot flame is on or extinguished, respectively. The thermocouple assembly may also be used with the "sparking pilot", if desired. The above embodiments of the present invention will now be described in greater detail below.

The track **44** is common to all embodiments of the invention. Referring to FIGS. **1–3**, and particularly to FIGS. **4***a*–**4***c,* the track **44** has an elongate u-shaped channel or rail **46** extending generally parallel to the stack **32**. The channel **46** is mounted onto a generally cylindrical exterior wall **48** of the stack **32** by a number of support brackets **50** distributed along the length of the channel. A carrier **52** for carrying the pilot **40** and pilot housing **42** is slideably mounted on the channel **46** using one or more c-shaped brackets **53** (preferably two), and may be moved along the channel using a motorized or hand operated winch **54** (FIG. **1**) which engages a continuous cable **55** running around upper and lower pulleys **56** and **58**, respectively, located at each end of the channel **46**. The winch also keeps the cable **55** taut. Stops (not shown) are provided on the channel **46** to limit sliding of the carrier **52** between a fully lowered, inoperative position (FIG. **1**) and a fully raised, operative position (FIG. **2**). A pair of spaced lower arms **60** on the carrier **52** pivotally connect the bottom end of the pilot housing **42** to the carrier, and a pair of spaced upper arms **62** detachably connect an intermediate portion of the housing **42** to the carrier in a generally vertical orientation by inserting pin **63** through aligned holes **64** when the housing is located between the upper arms **62**.

An advantage of the track **44** is that the pilot housing **42** may be easily lowered from the operative position to the inoperative position and conveniently swung away from the stack **32** (as shown in FIG. **1**) for maintenance, repairs or the like. Returning the pilot housing **42** to the operative position is likewise convenient. Using channel iron for the track also offers several advantages: the pulley cable **55** and other cables hanging down (not shown) from the pilot housing in the operative position may be neatly hidden within the u-shaped channel **46** (as indicated in FIG. **4***c*) and pinned therein to prevent them from flailing in the wind and causing damage, and so the track (ie. channel) may be mounted closer to the stack than prior art tracks; and, mounting of the pulleys **56**, **58** onto the channel **46** is easier than onto prior art tracks. It is also noted that the upper portion of the channel **46** is inclined toward the flare stack **32** to facilitate insertion of the pilot housing **42** into the stripper **36** and to tip the upper end of the pilot housing toward the conduit **38** as discussed later.

Still referring to FIGS. **1–3**, an important feature of the invention is the stripper **36** present in all embodiments. The stripper **36** provides a means for the pilot **40** to in effect ignite the gases escaping the flare stack **32** from a location remote from the terminal end **34** of the stack. Hence, as discussed later, the pilot **40** is not subjected to the same intense heat and direct flow of stack gases were it located right by the terminal end **34**. The stripper also acts as a wind shroud for the pilot.

The stripper **36** is in the form of a hollow cylindrical shell or tube **66** located adjacent the exterior wall **48** of the flare stack **32** and attached thereto by a bracket **68** and conduit **38**. An upper opening **70** of the tube **66** is located at about the same level as, or proximate to, the terminal end **34** of the flare stack, and a lower opening **72** is flared outwardly to help guide the pilot housing **42** into the stripper **36** when being lifted therein. The stripper is inclined toward the flare stack **32** to locate the upper end of the tube **66** closer to the stack **32** than the lower end. In the operative position the tip of the pilot housing **42** is located at about the same level as or preferably just below the entrance of the conduit **38** into the stripper **36** (by about 2 inches in the preferred embodiment). Since the stripper **36** is typically spaced closer to the stack **32** than the track **44**, the upper portion of the track **44** is also inclined to place the pilot housing **42** generally parallel to or in line with the tube **66** in the operative position. In addition, the tube **66** has a larger circumference than the pilot housing **42** to allow upward air flow through the stripper between the tube and the pilot housing. Good results have been had with a 4 foot (aprox. 122 cm) tall stripper made of stainless steel tubing having an inside diameter of between 2 to 3 inches (aprox. 51 to 76 mm). Although a shorter stripper may be used, it is desirable to keep the stripper relatively tall to space the lower opening **72** a good distance away from the stack's terminal end **34** where the hot flare is burning, thus avoiding drawing in heated air from the flare area into the lower opening **72** and instead allowing relatively cooler air to be sucked in for cooling purposes discussed below.

The hollow conduit **38** penetrates the sides of the tube **66** and the flare stack **32** below the upper opening **70** and the open terminal end **34**, respectively. In the preferred embodiment, the conduit **38** is about 2 inches (aprox. 51 mm) long, has a 0.5 inch (aprox. 12.7 mm) inside diameter, penetrates the stripper about 4 inches (aprox. 100 mm) below the upper opening **70**, and is cut flush with the inside surface of the stripper tube **66**. The conduit **38** provides a passage through which a portion of the gases moving up the flare stack **32** may flow into the stripper **36** for ignition by the pilot **40** to produce an ignition or secondary flame in the vicinity of the upper opening **70**. The ignition flame in turn ignites the gases exiting the terminal end **34** of the flare stack. To facilitate the flow of gases through the conduit **38**, the conduit is inclined upwardly from the flare stack to the stripper and extends slightly into the flare stack **32** as shown. An angle of about 45 degrees from the horizontal has produced good results because it brings gases into the stripper while directing the flow above the tip of the pilot housing **42** rather than directly onto the tip, which helps avoid corrosion of the ignition assembly, particularly the pilot housing. Combustion of the ignition flame is aided by air drawn through the stripper from the lower opening **72** to provide for a relatively clean burn. This flow or current of relatively cooler air from the bottom of the stripper also helps cool the pilot housing **42** and the pilot within.

As noted above, the stripper **36** accommodates both flame and sparking pilots. Reference is now made to the flame pilot. FIGS. **1–8**, but in particular in FIGS. **5–8**, show the flame pilot **40** of the first embodiment of the invention which must be lit manually by a technician (ie. the "manual light" version). Referring to FIG. **8**, the pilot **40** operates on fuel supplied from a fuel source (not shown), typically through a flexible high pressure hose **74** connected to the pilot's fuel line **74** via an elbow connection **76** having a fuel filter **77**. The fuel line **78** communicates with a conventional venturi orifice **80** for introducing air to the supplied fuel. The air and fuel then pass from the venturi **80** to a tube **83** forming a mixing chamber **82** of sufficient length to provide adequate mixture of the air and fuel. In the first embodiment, the tube **83** is made of 0.5 inch (aprox. 12.7 mm) diameter standard tubing, and the mixing chamber **82** within extends about 60 inches (aprox. 1524 mm) in length. However, good results have been achieved with a mixing chamber as short as 1 foot (aprox. 305 mm). The mixing chamber may also be longer than 60 inches, as might be used for pit igniters.

The air/fuel mixture then passes from the mixing chamber **82** through a flame spreader **84** located in a continuation of the same tube **83** which forms the mixing chamber **82**, shown in detail in FIGS. **9** and **10**. The construction of the flame spreader **84** is akin to a potion of a drill bit where one or more channels **86** wind around a solid core or hub **88**. A spiral or twisting motion is imposed on the air/gas stream as it passes through the channels **86** and exits into a combustion chamber **90** immediately above the flame spreader. The flame spreader not only further mixes the air/gas stream for better combustion but helps provide a back pressure in the mixing chamber **82** which helps propel the air/gas mixture into the combustion chamber. In the FIG. **9** embodiment there are two helical u-shaped channels **86** about the core **88** Optimal results have been achieved using a flame spreader with an incline or angle "P" (as measured to the longitudinal axis **89** of the core **88**) of about 30 degrees and a length L of about 1 inch (aprox. 25 mm). However, small variations of these configurations have also produced acceptable results, namely a pitch of between about 25 and 35 degrees and a length L of between 0.75 and 1.25 inches (aprox. 19 to 32 mm, respectively). The pitch should not exceed 35 degrees. The flame spreader **84** is seated about 1 inch (aprox 25 mm) below the tip of tube **83**. This space above the flame spreader forms the combustion chamber **90** for combustion of the air/fuel exiting the flame spreader, which produces the pilot or primary flame. In operation, the pilot flame ignites the gases entering the stripper **36** through the conduit **38** to produce the ignition or secondary flame mentioned earlier.

The pilot **40** is located within the pilot housing **42** shown partly in ghost outline in FIG. **8** and in more detail in FIGS. **5**, **6** and **7**. The housing **42** comprises an elongate pipe made of stainless steel or other suitable corrosion resistant material and has an open first end **92** for insertion of the pilot **40** therein. Box-like tubing **94** is fixed to the first end **92** and has apertures **96** to pivotally mount the housing **42** to the lower arm **60** of the track carrier **52** using a pin or other conventional means. A larger hole **97** on an adjacent face of tubing **96** (and located closer to the first end **92** than the apertures **96**) accommodates a portion of the elbow connection **76** of the pilot **40**. A second end **98** of the housing has an opening **100** (see FIG. **7**) for exposing the pilot flame to the stripper **36**. Two opposed slots **102** are provided to permit the pilot flame to spread sideways.

Several bushings inside the housing (one of which is indicated by **104** in FIG. **7**) centre the pilot in the housing. The pilot and housing are sized for air flow at least between the open first end **92** and the venturi **80** to permit the previously noted mixing of air and fuel to take place. The venturi **80** is kept a considerable distance away from the first opening **92** to reduce the risk of dirt and debris reaching the venturi **80**. In the FIG. **8** embodiment the venturi **80** is about 55 inches (aprox. 1400 mm) from the opening **92**, namely about the length of the pilot fuel line **78**. Such spacing also has the added benefit of keeping the flexible fuel hose **74** as far away as possible from the heat of the flame atop the flare stack. The length of the housing **42** is also influenced by the location of the pilot's combustion chamber **90** within the housing. The combustion chamber **90** should sit right below the two housing slots **102**, namely the tip of tube **83** should just meet the bottom of the open slots **102** so that the pilot flame may spread sideways as noted above. As a result, the flame spreader **84** is located close to the slots **102**, namely about 1 inch (aprox. 25 mm) below, as indicated in ghost outline in FIG. **7**.

The second embodiment of the invention, namely the "auto-light" version shown in FIGS. **11–14**, essentially employs the same pilot **40** as in the first embodiment, but in addition the ignition assembly incorporates an electrode assembly **110**. Like reference numbers are used for features common to the first embodiment. The electrode assembly employs a conventional ceramic electrode **112** (FIG. **14**) having a spark producing tip **114** and an opposed tip **116** connected (using a spark plug type connector **117**) to a source of electric power (not shown) via an electric cable **118** and a coil box **120**. The electrode **112** is mounted in casing **122** using two slit bushings **124** with set screws, and the open bottom of the casing is accessible to the cable **118**. The casing **122**, a 0.75 inch (aprox. 19 mm) diameter pipe in this embodiment, is mounted beside the pilot housing **242**. Housing **242** differs from housing **42** of the first embodiment only in that the outside diameter or size of housing **242** is reduced from about 1 inch to about 0.5 inch (aprox. 25 mm and 12.5 mm, respectively) above the venturi **80** to take up less space in the stripper **36** to help accommodate the casing **122** and still allow air flow through the stripper. A top portion **126** of the casing **122** forms a plate which is electrically grounded and which is spaced from the electrode tip **114** to form a spark gap across which sparks travel when an electric current is introduced to the tip **114**. The top portion **126** extends above the open second end **98** of housing **242**. Some of the casing **122** at the side **128** adjacent housing end **98** is cut away so that any air/fuel mixture rising from the pilot's combustion chamber **90** through opening **100** is exposed to the above noted sparks to ignite the mixture, thereby relighting the pilot flame.

In the third embodiment of the invention, namely the "sensored auto-light" version shown in FIGS. **15–18**, the ignition assembly essentially has the same pilot **40** as in the first embodiment and the same electrode assembly **110** as in the second embodiment, but in addition incorporates a thermocouple assembly **130**. Like reference numbers are used for features common to the first and second embodiments. The thermocouple assembly **130** employs a heat sensor or probe **132** connected by a data transmission line **134** to a coil box **220** which in turn communicates with a temperature controller (not shown) which analyses data received from the sensor **132**. A stainless steel casing or chamber **136** for the sensor is located beside both the electrode casing **122** and the pilot housing **242** (FIG. **18**). The upper end **138** of the sensor casing **136** is placed at the same elevation as the electrode casing **122** (FIG. **15**), although unlike electrode casing **122** the sensor casing **136** is not cut out at the top but is completely enclosed to protect the sensor from the flame and corrosive gases. In operation, when the pilot flame is extinguished for some reason and the temperature at the sensor **132** falls below a pre-set value, say 212 degrees F. (aprox. 100 degrees C), the temperature controller activates the electrode assembly **110** to re-light the pilot **40**. When the temperature then begins to again recover and exceeds the same or another higher pre-set value (say 300 degrees F., or about 150 degrees C.) the temperature controller shuts off the sparking at the electrode **112**.

In a fourth embodiment of the invention shown in FIGS. **19–22**, the sparking pilot **140** mentioned earlier is substituted for the flame pilot **40**. Similarly to the flame pilot, the sparking pilot **140** has an elongate tubular housing **142** (FIGS. **19** and **20**) with an open bottom end **144** for receiving a two-part electrode **146** (FIG. **22**) therein. The pilot housing is mounted to the track **44** on the flare stack **32** the same way as pilot housing **42**, for instance by fitting the housing's bottom end **144** with box-like tubing **148** (similar to **94**) for pivotal connection to lower arm **60** of carrier **52**. The pilot housing **142** is insertable into the stripper **36** with the housing's top end **150** located immediately below the mouth of conduit **38**. The electrode **146** is connected to a coil box **152** which in turn communicates with a power source (not shown) by wire **154**.

Referring specifically to FIGS. **21***a,* **21***b* and **22**, the electrode **146** comprises a ceramic upper part **146***a* and a ceramic lower part **146***b* having a bottom tip **156** which is wired to the coil box **152**. The electrode forms two spark gaps, one between the opposed tips **158** and **159** of the upper and lower parts **146***a* and **146***b,* respectively, and the other gap between the top tip **160** of part **146***a* and the top end **150** of the housing **142**. The housing's top end **150** forms a donut shaped disk **161** with an aperture **162**, and the electrode tip **160** has a plate-like tip which is spaced from the disk **161** to form one of the spark gaps. The housing has an upper and lower set of spaced slots **166** and **168** which expose the above mentioned spark gaps to the gases which have entered the stripper through the conduit **38**. When an electric current is supplied to the electrode **146** at tip **156**, arcing takes place simultaneously across both gaps. This dual gap arrangement has been found to be advantageous where there are fluctuations of gas volumes in the stack, and hence in the stripper as well.

If fluctuations of gas flow volumes are not expected in the stripper **36**, then the single spark gap version of the sparking pilot shown in FIGS. **23**, **24***a* and **24***b* may be used instead. A difference with the single gap version is that the top end **150** of the housing **142** forms a solid plate (omitting aperture **162**) and the electrode tip **160** is pointed (and not flat like **164**).

The sparking pilot **140** of FIGS. **19–24***b* may also be installed with a thermocouple assembly **130** (as for pilot **40**) to control sparking of the electrode **146**.

A detailed schematic view of the wiring in the conventional coil box **152** is shown in FIG. **25**. The box typically has a high voltage transformer **170** for increasing the voltage from a low voltage power source (say 6–24 V) to about 12,000 V, and a booster **172** to further increase the voltage to about 20,000 V or more, as required. The transformer and booster are wired to a terminal strip **174** which has vacant spots **175** for use with other hardware, such as a thermocoupler, if provided. AC or DC power may be used from diverse sources such as solar panels or thermal generators. An advantage of locating the transformer on a pilot housing rather than at the power source (typically located away from the flare vent near ground level and communicating with the vent by a high voltage line) is the reduced risk of electric shock to anyone in the vicinity of the vent.

It can now be appreciated how the ignition assembly of the present invention functions and some of the resulting benefits. For illustrative purposes and ease of reference, the third embodiment of the flame pilot **40** (ie. the sensored auto-light version) will be referred to since it encompasses the most features. With the pilot, electrode and thermocouple assemblies fully mounted to the carrier **52** and in a lowered inoperative position, a technician engages the winch **54** to slide the assemblies along the channel **46** to an operative position within the stripper **36** in which the opening **100** of the pilot housing **42** is spaced from and just below the conduit **38**. The winch is locked to maintain said operative position. The ignition assembly is then activated by opening up the fuel supply to the pilot **40** and by initiating the electrode and thermocouple assemblies **110** and **130**, respectively. The electrode **112** should begin sparking right away since the sensor **132** of the thermocouple does not register any heat from a flame. When the fuel reaches the combustion chamber **90**, the sparks should ignite the fuel, thereby creating the pilot flame at the open end **98** of the pilot housing. The sparking should stop at some point afterwards, depending on the chosen temperature control setting and the time it takes for the temperature at the sensor to reach that pre-set value. As the pilot flame bums it draws air through the stripper from the lower opening **72** which causes an intense high pitched whistling sound audible from hundreds of yards away from the stack. Since the pilot flame is normally obscured from view by the stripper, this sound indicates to a technician that the pilot flame is burning without actually having to visually inspect the pilot **40**. The air drawn through the stripper also helps the pilot bum more cleanly and helps to cool the pilot, electrode and thermocouple assemblies within the stripper.

Since the pilot flame bums at the mouth of the conduit **38**, gases entering the stripper through the conduit **38** ignite causing a larger "secondary" burn to take place at the upper opening **70** of the stripper. This bum is called the ignition flame because it in turn ignites the gases exiting the open terminal end **34** of the flare stack **32**. As the ignition flame bums it also draws air through the stripper **36** for burning purposes. Hence, the ignition assembly **30** uses a portion of the waste gases from the flare stack to produce the ignition flame which in turn ignites the remaining gases exiting the stack. This arrangement contributes to the significantly lower fuel consumption of the flame pilot according to the present invention. Tests of the flame pilot have resulted in fuel (ie. propane) consumption of about 2.5 liters (about 3 US quarts) per day, as opposed to between 4 to 6 liters or more of propane for prior art ignitors.

The ignition assembly **30** provides a type of "fail-safe" ignition system for the stack. In all embodiments, should the flow of gases in the stack be interrupted for any reason, then the ignition flame will be extinguished but the pilot flame should continue to burn (ie. or to spark in the fourth embodiment). Upon resumption of gas flow up the stack, the ignition flame will be ignited again as noted above. Should the pilot stop functioning for any reason (e.g. no fuel or electricity), then the ignition flame should continue burning as long as there is sufficient gas flow through the conduit **38** from the stack. In all embodiments except for the first (manual relight), running out of fuel should not affect the ignition flame because the sparking of the electrodes should re-ignite the gases from the conduit **38** if the ignition flame is extinguished.

Another advantage of the present invention may now be better appreciated. The pilot housing **42** and the pilot therein should require less maintenance and replacement than existing ignitors because the housing and pilot are located some distance away (about 6 inches (aprox. 152 mm) in the preferred embodiment) from the main burn at the terminal end of the stack, which produces much more heat than the pilot flame or ignitor flame. Prior art ignitors are located right in or beside the main burn, which exposes the ignitor to intense heat and corrosive gases. In comparison, the pilot **40** (in particular the flame spreader **84**) is kept below the flames and away from the gases exiting the terminal end of the flare stack. Even the gases flowing through the conduit **38** are introduced to the stripper above the pilot. Hence, the stainless steel and other materials of the ignition assembly **30** are less distressed than in other prior systems. In tests of the present invention, temperatures registered by the thermocouple adjacent the pilot **40** ranged between 120 degrees C to no more than 300 degrees C.

The flame pilot according to the present invention also does not require very high fuel pressure to function. Good pilot flames have been achieved with as little as 3 psi of propane pressure. Comparable prior art systems function on between 12 to 18 psi of pressure. This advantage is attributed in part to the configuration of the flame spreader **84** and the fuel line elbow connection **76** which has relatively few bends.

The above description is intended in an illustrative rather than a restrictive sense and variations to the specific configurations described may be apparent to skilled persons in adapting the present invention to specific applications. Such variations are intended to form part of the present invention insofar as they are within the spirit and scope of the claims below. For instance, a nipple may be located in the wall of the mixing chamber in pilot tube **83** below the flame spreader **84** to purge the tube of any fluid which might enter through the flame spreader and threaten to obstruct or hamper fuel flow to the combustion chamber **90**.

We claim:

1. An ignition assembly for a flare vent having an open terminal end for venting waste gases comprising:

- a stripper comprising a generally hollow tubular member located adjacent a generally upright exterior wall of said flare vent, said tubular member having a lower opening and an upper opening proximate to said terminal end of the flare vent;
- a conduit for waste gas communication from said flare vent to said stripper, said conduit being located below both said upper opening of the stripper and said terminal end of the flare vent;
- a pilot having an igniting end for igniting waste gases entering said stripper through said conduit to produce an ignition flame at said upper opening of the stripper, said ignition flame igniting waste gases exiting said terminal end of the flare vent, wherein said pilot comprises:
  - a fuel supply line for transporting fuel from a fuel source;
  - a venturi orifice in communication with said fuel supply line for introducing air to said fuel;
  - a mixing chamber for receiving said air and fuel from said venturi orifice, said mixing chamber being of sufficient length to allow adequate mixing of said air and fuel when passing through said mixing chamber;
  - a flame spreader for further mixing of said air and fuel mixture received from said mixing chamber and for creating a back pressure in said mixing chamber; and
  - a combustion chamber for combusting said air and fuel mixture exiting said flame spreader to produce a pilot flame;

an elongate tubular housing for said pilot having an open top end for exposing said pilot igniting end to waste gases in the stripper, wherein said housing is insertable into said stripper and when inserted allows air flow through said stripper for producing said ignition flame and for cooling said top end of the housing; and

a track attached to said exterior wall of the flare vent for moving said housing and pilot between an inoperative position near the base of said flare vent and an operative position near said terminal end of the flare vent, wherein in said operative position said first end of the housing and said pilot are located within said stripper below said conduit;

wherein in operation said combustion chamber is located below said top end of said pilot housing and said pilot flame ignites gases entering said stripper through said conduit to produce said ignition flame at said upper opening of the stripper.

2. The ignition assembly of claim **1** wherein an electrode assembly having a source of electric power is located adjacent said combustion chamber for providing sparks to initiate said combustion in the combustion chamber.

3. The ignition assembly of claim **2** wherein a thermocouple assembly having a control means is located adjacent said combustion chamber to control said sparking from the electrode assembly, said sparking being activated when the temperature in said combustion chamber falls below a first pre-set value, and said sparking being disengaged when said temperature exceeds a second pre-set value.

4. The ignition assembly of claim **1** wherein said flame spreader comprises at least two helical channels about a hub to spiral the flow of the air and fuel mixture passing therethrough from the mixing chamber to the combustion chamber.

5. The ignition assembly of claim **4** wherein the incline of said channels is between about 25 and 35 degrees to the longitudinal axis of said hub.

6. The ignition assembly of claim **5** wherein the length of said flame spreader along said longitudinal axis is between about 0.75 and 1.25 inches.

7. The ignition assembly of claim **6** wherein said flame spreader is about one inch in length and has two helical channels with an incline of about 30 degrees.

8. The ignition assembly of claim **1** wherein said pilot comprises an electrode assembly having a source of electric power for providing sparks to ignite said ignition flame, said electrode assembly comprising a first pair of electrodes wherein a first electrode connected to said source of electric power is spaced from a second grounded electrode to form a spark gap therebetween, said source being controlled to provide a spark across said spark gap at a preset frequency.

9. The ignition assembly of claim **8** wherein said sparking is controlled by a thermocouple assembly having a control means located in the vicinity of said ignition flame to control said sparking, said sparking being activated when the temperature of said pilot falls below a first pre-set value when said ignition flame is extinguished, and said sparking being deactivated when said temperature exceeds a second pre-set value.

10. The ignition assembly of claim **8** wherein said first electrode forms a generally pointed arcing surface which is oriented substantially perpendicular to said second electrode having a generally planar arcing surface, said first electrode being located below said second electrode when said electrode assembly is in said operative position.

11. The ignition assembly of claim **8** wherein said electrode assembly includes a second pair of electrodes located below said first pair of electrodes when said electrode assembly is in an operative position.

12. The ignition assembly of claim **11** wherein said pilot housing includes at least one opening adjacent said second pair of electrodes for exposure to said gases entering said stripper through said conduit.

13. The ignition assembly of claim **8** wherein said conduit penetrates said exterior wall of the flare vent and a sidewall of said tubular stripper, said conduit being inclined upwardly away from said exterior wall of the flare vent to direct waste gases away from said pilot housing when first exiting said conduit and to facilitate movement of waste gases from the flare vent to the stripper.

14. The ignition assembly of claim **13** wherein said conduit is spaced at least 4 inches below said upper opening of the stripper.

15. The ignition assembly of claim **13** wherein said incline forms an angle of about 45 degrees between said conduit and said exterior wall of the flare stack.

16. The ignition assembly of claim **13** wherein said stripper is inclined relative to said flare vent so that said pilot housing is positioned generally parallel to said stripper when in said operative position, said stripper being spaced from said exterior wall of the flare vent with the lower opening being spaced further from said exterior wall than the upper opening.

17. The ignition assembly of claim **16** wherein said lower opening of the stripper is flared outwardly to guide said pilot housing into the stripper upon insertion therein.

18. An ignition assembly for a flare vent having an open terminal end for venting waste gases comprising:

a stripper comprising a generally hollow tubular member located adjacent a generally upright exterior wall of said flare vent, said tubular member having a lower opening and an upper opening proximate to said terminal end of the flare vent;

a conduit for waste gas communication from said flare vent to said stripper, said conduit being located below both said upper opening of the stripper and said terminal end of the flare vent;

a pilot having an igniting end for igniting waste gases entering said stripper through said conduit to produce an ignition flame at said upper opening of the stripper, said ignition flame igniting waste gases exiting said terminal end of the flare vent;

an elongate tubular housing for said pilot having an open top end for exposing said pilot igniting end to waste gases in the stripper, wherein said housing is insertable into said stripper and when inserted allows air flow through said stripper for producing said ignition flame and for cooling said top end of the housing; and

a track attached to said exterior wall of the flare vent for moving said housing and pilot between an inoperative position near the base of said flare vent and an operative position near said terminal end of the flare vent, wherein in said operative position said first end of the housing and said pilot are located within said stripper below said conduit;

wherein said conduit penetrates said exterior wall of the flare vent and a sidewall of said tubular stripper, said conduit being inclined upwardly away from said exterior wall of the flare vent to direct waste gases away from said pilot housing when first exiting said conduit and to facilitate movement of waste gases from the flare vent to the stripper.

19. The ignition assembly of claim **18** wherein said conduit is spaced at least 4 inches below said upper opening of the stripper.

20. The ignition assembly of claim **18** wherein said incline forms an angle of about 45 degrees from the horizontal.

21. The ignition assembly of claim **18** wherein said stripper is inclined relative to said flare vent so that said pilot housing is positioned generally parallel to said stripper when in said operative position, said stripper being spaced from said exterior wall of the flare vent with the lower opening being spaced further from said exterior wall than the upper opening.

22. The ignition assembly of claim **21** wherein said lower opening of the stripper is flared outwardly to guide said pilot housing into the stripper upon insertion therein.

23. The ignition assembly of claim **21** wherein said pilot housing and portions of said electrode assembly and thermocouple assembly are located side-by-side in said stripper and are sized so that air flowing through said stripper forms an audible whistle in the presence of said pilot flame to indicate that said pilot flame is burning.

24. An ignition assembly for a flare vent having an open terminal end for venting waste gases comprising:

a stripper comprising a generally hollow tubular member located adjacent a generally upright exterior wall of said flare vent, said tubular member having a lower opening and an upper opening proximate to said terminal end of the flare vent;

a conduit for waste gas communication from said flare vent to said stripper, said conduit being located below both said upper opening of the stripper and said terminal end of the flare vent;

a pilot having an igniting end for igniting waste gases entering said stripper through said conduit to produce an ignition flame at said upper opening of the stripper, said ignition flame igniting waste gases exiting said terminal end of the flare vent;

an elongate tubular housing for said pilot having an open top end for exposing said pilot igniting end to waste gases in the stripper, wherein said housing is insertable into said stripper and when inserted allows air flow through said stripper for producing said ignition flame and for cooling said top end of the housing; and

a track attached to said exterior wall of the flare vent for moving said housing and pilot between an inoperative position near the base of said flare vent and an operative position near said terminal end of the flare vent, wherein in said operative position said first end of the housing and said pilot are located within said stripper below said conduit, and wherein said track comprises:

an elongate u-shaped channel extending generally vertically along the exterior wall of the flare vent;

a plurality of brackets for spacing the channel from said exterior wall and for supporting said channel on said exterior wall;

a carrier slideably mounted on said channel, said carrier having at least one lower arm to which a bottom end of said pilot housing is pivotally connected, and at least one upper arm for removably connecting an intermediate portion of said pilot housing to said carrier, wherein in said inoperative position said pilot housing may be detached from said carrier at said upper arm and pivoted about said lower arm for maintenance; and

a pulley mounted adjacent each end of said channel, and a pulley cable running between said pulleys and attached to said carrier for raising and lowering said carrier.

25. The ignition assembly of claim **24** wherein said channel: is made of channel iron for mounting close to said exterior wall of the flare vent; is adapted to house said pulley cable and any other wires or cables of the ignition assembly extending along the exterior wall of the flare stack; and, is inclined at an upper portion thereof toward said flare vent to tip said pilot housing toward the terminal end of said flare vent in said operative position.

26. An ignition assembly for an upright flare vent having an open terminal end for venting waste gases comprising:

a generally elongate pilot having an igniting end;

a generally elongate sleeve housing said pilot, said sleeve having an open top end for exposing said igniting end to the ambient;

a hollow stripper mounted adjacent an exterior wall of said flare vent, said stripper having opposed upper and lower openings, said upper opening being located adjacent said terminal end of the flare vent;

an elongate tubular conduit located between said upper opening and said lower opening of the stripper for diverting a portion of said waste gases from said flare vent into said stripper, said diverted gases forming a stream upon exiting said conduit in said stripper, said conduit being inclined to said exterior wall of the flare vent to direct said stream of diverted gases above said open top end of the sleeve when first exiting said conduit; and,

a track attached to said exterior wall of the flare vent for locating said igniting end of the pilot and said first end of the sleeve in said stripper in close proximity to said stream of waste gases from the conduit.

27. The ignition assembly of claim **26** wherein said stripper includes means for maintaining said igniting end of the pilot below a preset temperature.

28. The ignition assembly of claim **27** wherein said maintaining means comprises a space between said stripper and said sleeve for allowing air flow from said lower opening of the stripper to said end of the sleeve for cooling said igniting end of the pilot and said sleeve.

29. The ignition assembly of claim **28** wherein said maintaining means further comprises locating said lower opening of the stripper a sufficient distance from said upper opening and from said igniting end of the pilot to avoid the intake of air heated by a flare at the terminal end of the vent into said lower opening.

30. The ignition assembly of claim **29** wherein said lower opening is located at least three feet from said igniting end of the pilot when inserted in said stripper.

31. The ignition assembly of claim **26** wherein said stripper is spaced from and inclined to said exterior wall of the flare vent.

* * * * *